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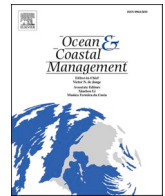
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## A critical social perspective on deep sea mining: Lessons from the emergent industry in Japan

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### ABSTRACT

In 2017 the Japanese government reported that its state-owned mining company had successfully extracted zinc from the seabed off the coast of Okinawa. This piloting of technology is currently the world's only example of large-scale extractive activity operating at such depths. Alongside Japan's innovations, the global deep sea mining (DSM) industry is moving towards commercial viability. This paper draws upon critical theoretical perspectives to better understand the complex debates being provoked. While there has been an increasing range of scholarship focusing on DSM from both the natural and social sciences, this paper cautions that the social sciences are not merely tools for assessing public and stakeholder acceptability. They require and deserve a central role in defining the purpose, nature and scope of commercial DSM. This paper therefore develops an approach that seeks to diversify and broaden engagements with DSM and that is well-placed to navigate the political questions that emerge from mining on the seabed. These perspectives also enable us to interrogate claims that DSM offers greater 'sustainability' than terrestrial mining does. This paper's interdisciplinary approach draws on empirical reference to, and examples from, the Japanese context, highlighting four main areas of concern for DSM: geography, geopolitics, law and political economy. These areas of critical enquiry reveal DSM's complexities and caution against perceiving DSM as a singular phenomenon. The emergent complex and multi-scalar questions from seabed mining therefore require a more holistic approach. Mining the seabed produces, and is underpinned by, a multitude of social, cultural and political dimensions and the potential consequences of DSM will not be experienced evenly. As this paper demonstrates, DSM is an interdisciplinary issue. The confines of disciplinary norms must therefore be exceeded to facilitate a deeper understanding of both the practices of DSM and their consequences.

### 1. Introduction

In late 2017, it was widely reported by the Japanese government that its state-owned mining company – Japan Oil, Gas and Metals National Corporation (JOGMEC) – had successfully extracted zinc from the seabed 1,600 m deep off the coast of Okinawa. Professed to contain 'the

equivalent to Japan's annual consumption' of the metal, the Japanese Ministry of Economy, Trade and Industry were quick to herald the seabed's transformative potential (Japan times, 2017). A new political and economic imaginary was invoked in which a focus on deep-sea mining (DSM)<sup>1</sup> could shift Japan from being a resource importer to being 'a resource-producing nation' (Japan times, 2017). In doing so, it

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<sup>1</sup> While definitions of DSM are varied, this paper focuses on three categories of deposit; seafloor massive sulphides, polymetallic nodules and cobalt-rich crusts which occur at depths of over 1000 m.

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mobilised the unique ‘magical’ power of ‘new’ resources to transform the state in politically expedient ways (Coronil, 1997). The deep seabed is ‘conjured’ (Tsing, 2003) surfaced, scaled-up and subsumed into the material fabric of the nation state itself. This brings Japan, now understood as a ‘resource nation’, into new relations with the emerging international discourses and practices of DSM.

Beyond Japan, the global DSM industry is moving towards the threshold of commercial viability. Therefore, there is a need to draw upon critical theoretical perspectives to better understand the complex debates being provoked. This is necessary in order to analyse the competing narratives of DSM and its practices across different sites and scales (local, national and global). This also requires a critical exploration of the wide range of political actors (both human and non-human) involved with DSM and the associated tensions and relations that emerge. These perspectives can help us to better interrogate the industry’s claims that DSM offers greater ‘sustainability’ and enable consideration of the spatio-temporal dimensions involved. We aim to incorporate these conceptual aspects into an approach that is better attuned to apprehending DSM and which offers a means to go beyond the usual treatment given to understanding DSM by both the social sciences (which focus on stakeholders, cost-effectiveness, Environmental Impact Assessments (EIAs) and discussions of the ‘precautionary principle’) and the natural sciences (and their focus on technology development and environmental impacts). These are of course important, but miss some crucial perspectives found in the literature on resource politics more generally. We caution that the social sciences are not merely tools for assessing public and stakeholder acceptability, but rather require and deserve a central role in defining the purpose, nature and scope of commercial DSM.

In this paper we develop an approach that seeks to diversify and broaden engagements with DSM and that is well-placed to deal with the political questions that emerge from mining on the seabed. We do so by breaking down our critical enquiry into four main areas of concern for DSM: 1) geography, 2) law, 3) political economy and 4) geopolitics. In each case, we focus critically on the *discourse* and the *practices* used to describe, mobilise and understand DSM. With regards to ‘discourse’, we argue first that the choice of language used in relation to DSM – including but not limited to ‘blue growth’, ‘resource frontier’ and ‘resource security’ – has particular political ramifications for how DSM is accepted or contested by society, including in Japan. Secondly, we demonstrate that a common understanding of the language used by both the natural sciences and the social sciences is needed if we are to address DSM’s emerging challenges. As we illustrate, DSM is an interdisciplinary issue and the confines of disciplinary norms must be exceeded to understand its complexities. With regards to ‘practices’, we seek to highlight the tensions between national and global forms of governance, regulation and deep-sea resource making. We draw upon the concept of ‘edges’ – both as legally-produced lines that define the extent of a legal space, and as indivisible ‘edges’ that define the limits of social inclusions and exclusions – to illustrate that understanding the ocean as a political space is essential to discussions of DSM. We also seek to push back against the idea that DSM is only located in the deep sea. It is a process that, like other ocean-based practices cannot be considered as untethered from terrestrial land (see Peters and Steinberg, 2019). Therefore, DSM must instead be connected to coastal and landed politics at all scales.

Although the approach we propose draws predominantly on theoretical concepts – from geography, law, political economy and geopolitics – we illustrate its applicability with empirical reference to, and examples from, the Japanese context. Although the world’s first commercial mining lease was issued to the *Solwara 1* project in Papua New Guinea (PNG) in 2011, the contractor, Nautilus Minerals, has been unable to begin operations due to financing problems and is facing liquidation. This has left Japan’s piloting of technology as the world’s only large-scale example of extractive activity to operate at such depths. We use this case both to highlight the questions that it raises and to offer

a critical approach for thinking about their provocations.

## 2. Geographies of deep-sea mining

DSM has physical geographies. Geological processes occur over space and time and interact with the physical environment. Three types of deep seabed mineral deposits have attracted commercial interests: polymetallic sulphides, polymetallic nodules, and cobalt rich crusts (Van Dover, 2010). Childs (2020a) notes that these deposits are formed over different timeframes, and at different depths which has implications for the types of technologies utilised for extraction and for the political implications that arise. The unique (geo)physical characteristics of the marine environment (including depth and volume) introduce their own complexities when it comes to understanding, establishing and verifying claims to ‘ownership’ of deposits (see Campling and Colás, 2018). Depending on the exact seabed location and distribution of minerals, differing cultural, national and international norms and relations may also come into play (Filer and Gabriel, 2018; Roche and Bice, 2013). Moreover, DSM does not only involve the seabed. As an activity involving extraction, transportation and processing, DSM happens within – and has the potential to impact upon – the water column, the sea surface and the land (Childs, 2020a). DSM also has impacts on biodiversity, similar to those associated with other activities on the seabed (Gasparatos et al., 2016; Van Dover, 2011). Disturbances to ecosystems at (or near to) the seabed, such as noise pollution, increased water turbidity and the release of toxic materials, have the potential to alter the characteristics of the marine environment and hinder the movements and feeding of aquatic species (Gasparatos et al., 2016). Attention to the physical geographies of DSM is hence a valuable starting point in recognising that DSM is not a homogenous entity. DSM may have varying physical manifestations – with wide ranging social, political and cultural implications – that vary between contexts.

Human geography, alongside other disciplines in the social sciences, are crucial to understanding this heterogeneity. As Roche and Bice (2013) highlight, human interactions with minerals can vary across time, space, and scale and involve multiple, and sometimes conflicting actors. They hold that national or regional discourses on ownership, authority and cultural rights may conflict with those of local communities (Roche and Bice, 2013). Andrea Koschinsky et al. (2018) add that DSM projects may be experienced differently by different people depending on their proximity and relationship to that project, and that an understanding of how social representations of DSM are interpreted in different countries and contexts is still lacking (Childs, 2020b). When it comes to the governance of DSM, these points illustrate how the space and scale over which negotiations around social licences and affected communities are held are not ‘natural’; rather, they are constructed and defined by a breadth of actors including corporate representatives (Filer and Gabriel, 2018). Again, a long-established geographical tradition reminds us that the matter of what is included within and excluded from considerations of DSM is subject to social and political choice. These inclusions and exclusions are (re)produced and maintained, premised on diverse and unequal power relations.

Recent work on DSM has begun to apply a critical view, informed by conceptual perspectives derived from the social sciences. Filer and Gabriel (2018), for instance, caution that established social licencing and impact assessment processes may be insufficient for facilitating the just operation of DSM. On this matter, Pierre-Yves Le Meur et al (2018: 382) argue that “the recognition of DSM mining in all its dimensions, including cultural aspects, is needed to design a relevant, well-dimensioned policy tailored to the country’s needs”. Therefore, there is scope for scholarly engagement with DSM to augment extant work by tapping into the broader conceptual turn towards the sea within critical social science. Indeed, marine social sciences are crucial to sustainable oceans, advocating in particular for consideration of the embedded historical roots and cultural connections society has to the ocean (see Gilroy, 1993; Hau’ofa 1994). This turn towards marine social

science or ‘blue humanities’ has the effect of “rendering vast oceanic space into ontological place” (DeLoughrey, 2017: 32), again illustrating the analytical purchase geographical thought can provide in thinking through the place of DSM within a sustainable society. Reflection on these more profound questions around society’s relationship with the oceans will be of particular value as DSM projects come closer to fruition.

Of course, DSM is not the only recent scholarly engagement with the ocean, seabed and subsurface. Recent works on subsea carbon dioxide capture and storage (CCS), oceanic carbon sequestration, and deep-sea oil exploration all illustrate the value of deeper conceptual engagement with the geographies of oceans as a complement to empirically focused social science (Bond et al., 2019; Mabon et al., 2017). For the Tomakomai CCS demonstration in northern Japan,<sup>2</sup> Mabon et al. (2017) argue that fishers’ responses to the project – the first of its kind in Japan and one of only a few in the world – makes sense in the context of a much longer history of contestation with local industries over the protection of the seabed and water column. Kamishiro and Sato (2009) similarly find that among the Japanese public, attitudes to oceanic carbon sequestration are informed not only by techno-scientific risk, but by individuals’ own environmental ethics. Meanwhile, research into contestation over deep-sea oil exploration in New Zealand (Ruckstuhl et al., 2014) illustrates how technocratic and outcome-driven processes of social licencing can fail to account for traditional, indigenous and local knowledges and understandings of the deep sea. Common to the above examples is that even for research with a more applied focus, engagement with human geographies of the ocean yields additional insight and analytical purchase.

In sum, DSM is not a single phenomenon, and cannot be understood by looking solely at the deep seabed, or through one disciplinary approach. Different deposits, and different parts of the DSM chain, have their own geographies and political economies. Likewise, relations with the different forms of DSM will depend on the social, cultural, and political context, in ways that cannot readily be assessed or quantified. Thinking about geographies can help to bring this richness and complexity to the fore.

### 3. Critical legal approaches to DSM

Legally, the ocean is a place of lines and limits. However, social science thinking enables discussions of DSM to move beyond this truism to understand how the law is applied to space and what the consequences of these applications are. Descriptions of the modern law of the sea routinely begin with a map containing lines that denote key divisions across and through a three dimensional and volumetric space (see Fig. 1.).

The borders of each of the above illustrated zones are defined by limits (for instance, at the 12 nautical mile point, where the territorial sea becomes the contiguous zone), and boundaries (for instance where one state’s territorial sea abuts the territorial sea of a neighbouring state). Notwithstanding contentious debates over where to draw boundaries at sea, the drawing of *limits* appears straightforward: once the baseline has been determined, one has merely to measure out the required number of nautical miles, draw a line, and hence a legal space is defined. Likewise, the key line dividing vertical layers in ocean-space –

the line between the water column and the seabed – is understood as unproblematic. Geographic divisions are thus considered to provide the basis for the application of different legal regimes, facilitated by maps that use lines to divide the spaces in which a given legal regime will apply.

This interpretation of the relationship between law and space, is contested by legal geographers. Geography, rather than occurring *prior* to the application of law, is actually the *outcome* of legal reasoning (see, for example, Benda-Beckmann et al., 2009; Blomley, 1994; Braverman et al., 2014; Delaney et al., 2001). This legal reasoning, however, is not without embedded power dynamics. As Alex Jeffrey (2020: 1) explains, “Law is a form of practice that is productive of an edge”. While Jeffrey is writing at one level about geographic edges – the legally produced lines on the ground that define the end of one legal space and the beginning of another – he argues that these spatial “edges” are inseparable from the “edges” that define the limits of *social* elements. This includes notions of jurisdictional authority, citizenship, and rights, as well as a host of other inclusions and exclusions that are defined through the practice of legal reasoning. Jeffrey argues that efforts to define the geographical limits of a place, which one might at first glance assume to be the starting point for determining the limits of legal authority, are, in fact, both a result and a means of reproducing legal power. Defining a space’s edge, and determining the standards by which that edge will be drawn, is imbricated with efforts to define what that space is.

In the seabed, this practice of constructing “edges” is apparent in the very designation of the continental shelf as a juridical place, and this must be considered in relation to DSM. The United Nations Convention on the Continental Shelf (United Nations, 1958a) defined the continental shelf as

the seabed and subsoil of the submarine areas adjacent to the coast but outside the area of the territorial sea, to a depth of 200 metres or, beyond that limit, to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas

(Art. 1).

Aside from being strikingly vague – the article was silent on whether the “exploitation of the natural resources” must be cost-effective given land-based alternatives, or on whether the limits of the continental shelf would need to be redrawn if the economic or technological environment for exploitation were to change – this definition is notable for what it was *not*. For a feature that is fundamentally geological, there is no mention of any geological criteria, nor is there a strict bathymetric criterion: the continental shelf is simply the seabed that is beneath water that is “adjacent” to the territorial sea and that promises economic value.<sup>4</sup>

A decade after the abovementioned Convention was promulgated, when the International Court of Justice considered a series of interrelated delimitation cases in the North Sea, a new definition was put forward, with the continental shelf being defined as “constitut[ing] a natural prolongation of [a state’s] land territory into and under the sea” (International Court of Justice, 1969: 72). Ironically, by redefining the continental shelf as a *physical* space, the ICJ established a basis for understanding it, more completely, as a *political* space, the implications of which must be recognised. After the ICJ ruling, the continental shelf was no longer defined as just the economically useful part of the seabed to which a state maintained exclusive rights through the vague principle of adjacency; rather it was a geological (and hence seemingly natural) extension of state territory. Shortly after the North Sea decision, this geologic thinking was extended further in UNCLOS, which defined “the

<sup>2</sup> The objective of the project ‘is to demonstrate the viability of a full CCS system, from CO<sub>2</sub> capture to injection and storage’. One hundred thousand tonnes/year or more of CO<sub>2</sub> is being injected and stored in offshore saline aquifers in the Tomakomai port area (Sawada et al., 2018:3).

<sup>3</sup> No state has exclusive rights in the Area and non-living resources are managed by the International Seabed Authority (ISA) as the “common heritage of mankind” (CHM) (see Anderson, 2008; Lowe, 2012 for discussion of the CHM). The creation of the ISA to regulate this access has enabled the emergence of sovereign and private claims in this space (Campling and Colás, 2018: 781).

<sup>4</sup> In fact, the article is further hindered by the fact that the complementary 1958 United Nations Convention on the Territorial Sea (United Nations, 1958b) never defines “the area of the territorial sea”, so there is no way of knowing if waters are “outside” that area.



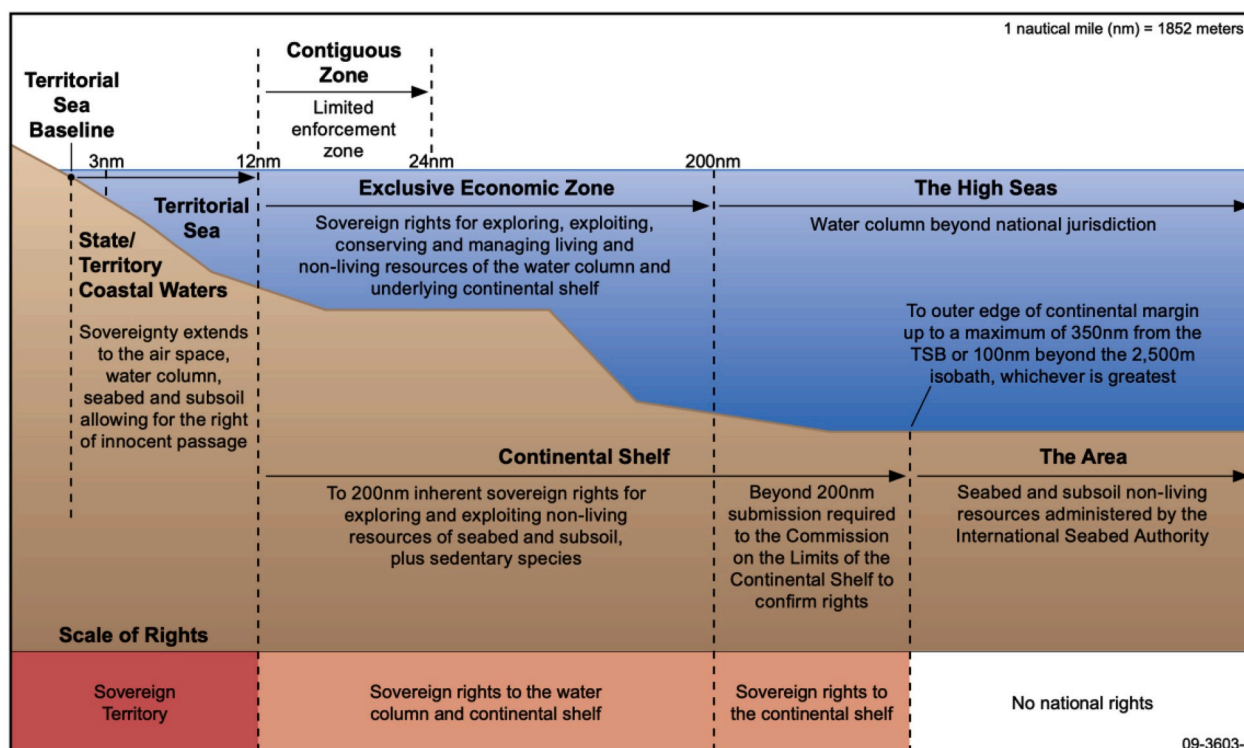


Fig. 1. Maritime divisions and rights to resources in the seabed<sup>3</sup> (NOAA, 2020: 22).

continental shelf of a coastal State” as “the seabed and subsoil of the submarine areas that extend beyond its territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin” (United Nations, 1982: Art. 76), as well as providing a series of technical geological and bathymetric criteria for determining where the “outer edge of the continental margin” lies.<sup>5</sup>

In drawing a new set of “edges” around the continental shelf, law came to define the edge of the state. No longer was the continental shelf an adjacent area wherein a state could exercise exclusive control; the continental shelf was now a “natural prolongation” of the state’s territory and hence a seemingly natural extension of the state, even if the state’s powers in that “natural prolongation” were mediated by the presence of superjacent ocean. The stage was thus set for regulating DSM as an extension of land-based mining on state territory, as opposed to, for instance, approaching seabed mining from a starting point informed by management of the water column. In Japan, the Mining Act regulates mining activities in both terrestrial and marine areas (GOJ, 1950: Act no.289).<sup>6</sup> Despite its scope, the Mining Act primarily regulates land-based extraction as seabed mining was not considered to be feasible at the time of its drafting. This is illustrated by the Act’s stipulation that applications for mining rights cannot exceed an area of more than 350 ha (3.5 square kilometres) (GOJ, 1950: Art.14). However, this size mining area does not satisfy most commercial DSM interests as seabed mineral deposits are often situated in wider areas than mineral deposits on land. In 2011 the Mining Act was updated to reflect this - allowing for an extension beyond this rule to enable the development of seabed mineral resources (GOJ 2011, Art 14(3)) – however, DSM remains primarily regulated as an extension of terrestrial mining. The unique challenges that emerge from the practice of DSM and the associated

questions of liability and legal responsibility in the event of unwanted consequences must, therefore, be considered. Current EIA law in Japan, for example, does not apply to DSM, raising questions of regulatory responsibility.

The redefinition of the continental shelf as the extension of state territory set the stage for the regime that emerged for the seabed beyond the continental shelf: the Area, which was designated in UNCLOS as the CHM (United Nations, 1982: Art. 136). As a space beyond the limits of state authority, it was not at all self-evident that the seabed beyond the continental shelf should be governed in any way within the state system. Or perhaps if it were to be governed within the state system then it might, like the High Seas, be governed according to the minimal principle that simply holds that all parties associate themselves with a single state and that they must not interfere with the actions of other state actors. Japan’s Act on Interim Measures for DSM, enacted in 1982, provides provisional regulations for mining activities by Japanese persons within the Area. The Act, which was based on the assumption that DSM could be conducted freely by individual states, does not reference either UNCLOS or to the ISA. Yet, it does not infringe upon other state’s interests and freedoms in the High Seas. However, such regimes would fail to give prospective miners (whether associated with states, corporations, or other entities) the security of tenure required before investing in deep seabed production, a concern that has subsequently emerged when designing and implementing DSM regulatory systems in areas of state jurisdiction as well, and which reflects underlying power relations. Japan’s interim measures also establish regulations regarding compensation for environmental and other damage incurred in Japan as a result of DSM. Japan is currently looking to the ISA for guidance on these measures: if the ISA adopts development rules in the upcoming Legal and Technical Commission (due to take place at the 26th session of the ISA in July 2020), Japan will look to reflect these in its national legislation (GOJa 2018).

To this end, and building on the precedent established on the continental shelf, the Area was designated as a land-like space, in which swathes could be licensed to private or public firms for exclusive extraction. Following the revisions of the Part XI Implementation

<sup>5</sup> UNCLOS Art. 76 also grants states exclusive right to the seabed out to 200 nautical miles in cases where the continental shelf does not extend that far.

<sup>6</sup> DSM activities in areas under national jurisdiction of Japan are, however, also subject to existing acts relating to maritime safety and marine environmental protection.

Agreement (United Nations, 1994), the only significant international component characterising resource extraction in the Area is a provision that the entire system be managed by the International Seabed Authority (ISA), which, in turn, is governed by State Parties to the Convention. The ISA is also responsible for the provision that a percentage of revenues is returned to the international community as compensation for land-locked states that may lose income due to seabed-based production. However, the ability of these states to claim compensation will likely be uneven, further reflecting unequal power relations.

As this section has discussed, regulatory systems cannot be understood by simply looking at how the law is applied to a space (in this case the ocean). Engagement with critical legal studies illustrates the value of understanding what ocean space *is* and how legally produced lines define social factors. These include matters of jurisdictional authority, inclusion and exclusion and how power imbalances are not only maintained but reproduced. These considerations are essential to understanding the complexities of DSM. As legal geography highlights, attention should be given to the relationships between the ocean, people and relevant social institutions (Bartel et al., 2013: 340). With the ocean being designated as a land-like space that is ripe for DSM, it is imperative that emergent discussions recognise that the ocean and associated sites of extraction are not only physical spaces but also political ones.

#### 4. Political economy

With the ocean defined as a political space, with economic potential therein, conventional economic paradigms have framed interest in DSM as a solution to resource scarcity and an increasing demand for minerals (Hoagland et al., 2010; WTO 2010). In fact, the 2019 Deep Sea Mining Summit website argued that, “as demand for base metals and minerals surges ever beyond what our land is able to provide, new technological and technical developments are helping to drive forward this new industry” (The Deep Sea Mining Summit 2019). However, interests in DSM reflect more than rational economic behaviour and, as this section highlights, the inherent social and political drivers must therefore be analysed. In doing so, this enables insight into how DSM, and the demand for DSM, is situated beyond the site of extraction.

The framing of the ocean – as pristine, as a hazard and/or as a resource – and the discourse used when discussing DSM offer insight into the drivers behind extraction. Terrestrial shortages and the perceived ‘rarity’ of resources often have little to do with a mineral’s scarcity and more to do with the absence of sites of extraction which are perceived as being without social or economic contention (see Klinger, 2018). The offshore and perceived ‘remoteness’ of the ocean (in dominant understandings within Western Europe and North America at least) enable the deep sea to be framed as an uncontested space: the absence of human habitation appearing to reduce or erase potential social or environmental consequences. Thus, the ocean is reframed as a resource (Hannigan, 2016: 13) with agendas such as the blue economy legitimising extraction under the guise of development. Historical imaginations that frame the ocean as space ripe for exploration and exploitation (see Rozwadowski, 2012:18), are propagated by blue growth discourse that (re)opens the ocean to imaginations of adventure, wherein new opportunities can be harnessed, and potential capital accumulated. With this framing comes the need for new governance and regulatory frameworks and institutions (Havice, 2018) which emerge from both state and non-state interests.<sup>7</sup> Therefore, demand for DSM must be considered not only economically, but also politically.

Given that interests in DSM extend beyond rational economic behaviour, it is important to locate mining, and the drivers of mining,

beyond the deposit. With the advent of “expectations from the UN Member States to bring management of their EEZs into line with international best practice” (Winder and Le Heron, 2017: 9), countries are increasingly engaging with blue economy initiatives under the guidance of external actors – including development actors and the private sector – with their own political and economic interests. Under such initiatives, new markets, including those for DSM, are opened with financiers supporting the state in the planning of these spaces and associated new markets (Havice and Zalik, 2019: 231). These economies are “being planned” under the auspices of external actors (Winder and Le Heron, 2017: 4). As such, the involvement of private corporations and financiers is integral to discussions of the marine scape as its unique (geo) physical characteristics require access to and possession of certain technologies, knowledges and finance.

Corporations and indeed associated external states have the power to shape how DSM is approached and occurs, both within the EEZ and the Area, particularly as investment is speculative and involves varying degrees of financial risk. As Jennifer Silver and Lisa Campbell (2018) argue, the commodification of the oceans is a product of speculation. This speculation can generate ‘contingent and unexpected outcomes’ (Campling and Colás, 2018: 77). When discussing DSM, it would therefore be astute to recognise the complexity of the mechanisms that finance extractive projects (Havice and Zalik, 2019) and the subsequent embedded power dynamics that accompany such exploration and exploitation. In the case of Japan, JOGMEC is a state-owned company. Unlike commercial operations, which would need to identify funding opportunities and obtain the required licences, JOGMEC has the latitude to develop extractive projects without such restrictions. However, this is not the case for all states that are considering exploitation. Recognising uneven power relations between states and external corporations is therefore paramount given the high costs and technological requirements of DSM exploration and extraction. The ownership and creation of knowledges relating to data and technology also reproduce uneven power dynamics, not just in terms of marine mineral extraction, but in terms of who gets to know the sea (Childs, 2020a).

The study of the political economy of any form of resource extraction, including DSM, must also understand how corporations operate both internally and externally to society. While the offshore location of DSM may appear to reduce the potential for social implications including the marginalisation of adjacent communities, claims to legitimacy in the sea do exist both through formal mechanisms of international law (e.g. rights to EEZs) and through informal customary claims (e.g. by indigenous and coastal groups that have long claimed the ocean, including the seabed, as part of their domain) (see Childs, 2020b). However, these claims may be subject to reduced capacity, exacerbated by the remoteness of the site of extraction. As discussed previously, the political economy of DSM also needs to be understood relative to the historical context within which it is situated. Histories of colonisation, resource nationalism, and market-oriented liberalisation shape contemporary extraction (Power et al., 2016). In the case of Namibia for example, the potential for marine phosphate mining<sup>8</sup> within the country’s EEZ cannot be understood without analysis of the embedded structures from its history of colonial rule. Namibia’s experience of colonialism and the effects of apartheid rule continue to present challenges to sovereign rights and the accrual of rent from extractive projects. Despite the state being positioned as an ‘abstract landlord’ of independent Namibia, there remain similarities between colonial and present-day relations (see Carver, 2019). This includes the exclusion of groups and individuals from discussions of and practices pertaining to ‘sovereignty, territory and mineral resources’ (Emel et al., 2011: 77). Similarly, continued reliance on external investment has, in some

<sup>7</sup> Exploitation in the ocean is “shaped by both socio-political contestation and cooperation (involving state agencies, trade unions, companies and international organisations, among other bodies) over the occupation, delimitation and appropriation of oceanic resources” (Campling and Colás, 2018:777).

<sup>8</sup> Marine phosphate mining is projected to occur at comparatively shallow depths (180–300 m - although deposits occur at depths of down to 800 m) than the DSM practices discussed in this paper.

contexts, perpetuated the potential for elite accrual of rent from extractive projects (Auty, 2007). While traditionally discussed in relation to terrestrial based extraction, concerns have been raised about the potential for political elites to accrue rent from extraction in the ocean (see Carver, 2019). Scholarship on DSM must therefore adequately engage with relevant contexts. This is also imperative within discussions of DSM outside of state's EEZs. Here the power and capacity of states to negotiate extraction and the technological and financial ability of states to exploit is uneven.

As with terrestrial mining, understanding how corporations operate within a society extends beyond the moment of extraction. All stages of extraction and production are essential components of the political economy of DSM. This includes waste,<sup>9</sup> which should be treated as a central component and not merely as a residual consideration or an afterthought. Methods of extraction are projected to produce plumes and involve the discharge of tailings and waste back into the ocean and, as scholars such as Boschen et al. (2013) have recognised, the environmental implications of waste stemming from DSM must be considered. While proponents argue that the waste and tailings arising from DSM will likely be lower than those caused by terrestrial mining due to deposits from the former being of a higher grade and closer to the seabed, it remains imperative to process and store the resultant potentially hazardous waste for which there is currently no alternative use (McLellan, 2015; Motoori et al., 2018). In Japan existing DSM regulations constrain the release of waste water if, as is common with sulphide deposits on the seabed, it contains high levels of arsenic (Motoori et al., 2015). While it is anticipated that this legislation will evolve to allow the release of wastewater, currently the use of high performance purification technology remains crucial to any efforts to extract.

It is important to recognise that waste is not just a technical issue (see Moore, 2011). The type(s) of waste, as well as decisions as to their definitions and how and where they are disposed of, are inherently political (Moore, 2011: 143). Waste from DSM will occur throughout the process – from extraction to production, manufacturing, consumption and finally to disposal – and new governance regimes will emerge (Knapp, 2016: 1890–91). Japan, for example, are discussing how to incorporate waste from DSM into their Marine Pollution Control Law (GOJa 2018). Discourse on DSM must avoid perpetuating the idea that 'waste can be removed' and instead acknowledge the 'uncertainties' associated with waste (see Balayannis, 2020:16). The management and disposal of waste is therefore important, and the latter is an uneven process that can result in the marginalisation of communities (Moore, 2011: 143; Pulido, 2000). Questions around who will experience and bear the consequences of waste from DSM must, therefore, be addressed. As Nunn (2018) and Davies (2019) highlight, inequalities and colonial logics are embedded in the production, processing and disposal of waste, the effects of which are unevenly shared, extending colonial practices into the 'intergenerational future' (Murphy, 2017:497). This makes feminist and anticolonial studies of paramount importance to the geographies of waste: including unpacking issues of inequality, (in)justice, lived experience and scale. Additionally, the offshore location of DSM must not blind one to the onshore waste associated with the production process. The ocean cannot be untethered from terrestrial territories, as the beneficiation of minerals may occur on land. In Japan, the requirement to secure resources conflicts with national and local interests over the storage, release and impact of DSM waste. Meanwhile, current solutions (such as importing concentrate or recycling waste domestically) serve only to displace these impacts (Motoori et al., 2018). The political economy of mining waste should therefore be considered across the process, challenging the imagination of the ocean as a pristine site of extraction existing solely offshore in isolation from the land.

As illustrated, the drivers of DSM cannot be fully understood by

engaging only with classical, market led, economic rationale. Analysing the discourse of extraction offers insight into the political drivers behind DSM, illustrating that the involvement of actors, including those beyond the state, must be recognised. Financiers and private corporations are increasingly involved in the creation of new markets, reflecting the imperative of locating mining, and the drivers of mining, beyond the deposit. The embedded power dynamics in, and environmental consequences of, DSM practices must also be considered. This prompts questions about the inequalities that are implicit in the production of sub-marine resource (both on and offshore). Such questions highlight the need to explore the contextual locations of DSM, allowing for their equally heterogeneous effects to be critically analysed.

## 5. Geopolitics

While the sea has been framed as a 'lucrative location for the extraction of natural resources', it can also be understood as a 'theatre of geopolitical rivalry and domination' (Campling and Colás, 2018:777). The geopolitics of DSM, like many of its other components, are multi-faceted, involving multinational corporations, the state, civil society groups both locally and globally, alongside more-than-human forces such as the deep ocean itself. Drawing upon recent work from political ecology that has understood state intervention as relational to other forms of non-human agency (Harris, 2017), this section highlights the notion that historic and geographic specificities matter for understanding the contemporary political relations of DSM. In all of the examples given below, the geopolitics of DSM features 'scalar practices' (Moore, 2008). The work that scale does – how it affects social power relations and institutions – must therefore be taken as a 'starting point' (Moore, 2008: 218), as opposed to considering scale as a 'concrete thing' (see Paasi, 2004: 537). In short, not only is DSM's geopolitics produced by different institutions, but it also has different effects according to how different political actors relate to each other across the socio-natural world. As feminist political geographers have long noted, attending to questions of scale is vital to unpacking the ways in which power operates and circulates (Massaro and Williams, 2013). These considerations enable the tracing of power, oppression and resistance that exists at, and between, multiple scales, sites and contexts (Massaro and Williams, 2013:567; see also Dowler and Sharp, 2001). As Hyndman (2001:219), notes, this is not promoting a new theory of geopolitics, but instead encourages a comprehensive analysis of the violence that 'traverses public/private distinctions.' In the context of DSM, this approach helps to tether what initially appear as 'distant places and problems together' (Massaro and Williams, 2013: 56). Firstly, it reveals that the deep sea is intricately connected to issues on land and vice versa. Secondly, it illustrates how state actors, corporations and international organisations are inextricably connected to communities and individuals.

This is, of course, not to say that the state is not important in shaping the geopolitics of deep oceans. This can be seen clearly in contemporary conflicts over sovereignty in the South China Sea between China (Singh and Yamamoto, 2016), the USA and regional states, or the now notorious instance of Russia's planting of a flag on the Arctic seabed in 2007 (see Dodds, 2010). These tensions can also be observed in the case of Okinotorishima, an uninhabited atoll located roughly halfway between Taiwan and Guam, which has been a subject of controversy between the Chinese and Japanese governments. Constituted of two barren rocks, located 1400 yards apart, Okinotorishima is visible at high tide less than two feet above the surface (Yamamoto and Esteban, 2014). The Japanese government argues that Okinotorishima is an island (Xue, 2012), and one that affords Japan a claim to the waters around it and the right to exploit natural resources therein. While the Chinese government recognises Japanese sovereignty over Okinotorishima, it maintains that it is a rock, and not an island, and therefore does not recognise Japan's

<sup>9</sup> While this paper focuses primarily on discussions of physical waste, the noise pollution associated with DSM practices must also be recognised.



claim to an EEZ around it (Yoshikawa, 2007).<sup>10</sup> These claims are further complicated by the rising sea level, which threatens low-lying islands (Esteban et al., 2018; Yamamoto and Esteban, 2009). However, Japan has already invested in the protection of Okinotorishima through the construction of circular blocks of steel, concrete barriers and the planting of corals around it (Hogg, 2007). Moreover, sea level rises will likely lead to larger-scale investment in protection works to ensure that Japan's claim to an EEZ around Okinotorishima remains.

For DSM more specifically, the tensions between states are clear in the narratives that define much of the global exploration efforts currently witnessed in the search for deep sea metals and minerals. A UK parliament report explicitly suggests deep-sea mining as a way to reduce the dependency on China for the import of critical rare earth elements (POST, 2015: 1–2). In Japan, it has been suggested by scholars that the extraction of copper from the deep seabed is a central part of the country's 'resource security strategy' in its shift away from being a net resource importer (Motoori et al., 2018). Japan's dependency on domestically scarce resources, including minerals and fossil fuels, has exposed it to supply risks that have driven the development of numerous innovations in more efficient consumption. Concurrently, Japan's energy security strategy focuses on the provision or production of resources domestically, as well as the increase of investment in companies and deposits external to Japan. However, the opportunity to domestically source metals in its EEZ remains alluring to Japan, despite its recognition that exploitation requires careful consideration (Motoori et al., 2018). The presence of offshore deposits in its EEZ has led Japan to undertake extensive exploration and development efforts for DSM as well as for methane hydrate deposits as a source of natural gas. DSM also appears in Japan's fifth Strategic Energy Plan (GOJb, 2018).

At the heart of these debates is an implicit focus on the idea of 'territory' – to first fix it as a factual object and then to assert the means to control it. Territory emerges as a 'political technology' which comprises various techniques deployed to 'measure ... control and manage terrain' (Elden, 2013: 17). However, while there are several exceptions (see Bruun, 2020; Peters et al., 2018; Squire, 2016 for example) most renderings of territory rest on a landed, terrestrial bias and do little to account for the three-dimensional geophysical specificities thrown up by the deep-ocean seabed. As has been asked elsewhere, 'how is DSM's politics to be considered in terms of its predominant definition' (Childs, 2020a: 20)? Is the seabed to be thought about as 'territory' in the same way as land, for example? In addition to addressing the question of what territory, in the context of the seabed, is or is not, is the question of how it is performed or made politically certain – its *territoriality* – and who has the power to define this process. In Papua New Guinea, for example, human actors such as the community groups living closest to the sites of proposed DSM activity are able to make particular claims on the deep seabed (Childs, 2019). For local communities, the sea is a space imbued with spiritual meaning – a stance that conflicts with corporations seeking to appropriate the sea floor (Childs, 2020b). Meanwhile, the notion of adjacency rights suggests that 'the people living on land contiguous to marine resources ought to have priority in developing these resources' (Foley and Mather, 2019). At the same time, corporate actors operating in that same 'territory' place great emphasis on the remoteness, volatility and mobility of the seabed and its associated fauna in order to destabilise such claims and to legitimise the rights of their involvement (Childs, 2019). The question of territoriality, and these competing 'terraqueous' claims (Campling and Colás, 2018:776), especially for 'the Area' (the seabed beyond the EEZ), renders these tensions over sovereignty even more 'unsettled' (Havice, 2018) yet nonetheless central to political debate over DSM.

<sup>10</sup> While rocks are like islands in that they are 'naturally formed area[s] of land, surrounded by water, which is above water at high tide' UNCLOS Art. 121 (1), islands can 'sustain human habitation or economic life of their own' (UNCLOS, supra note 2, at Art. 121(3)) (UN 1982).

Discussions of how to apportion and manage submarine 'territories' have also emerged in reference to the establishment of 'protected areas' in both states' EEZs and in the Area. Ecologically and Biologically Significant Areas (EBSAs) – areas that are defined as integral to the functioning of the ocean – have been designated in areas outside national jurisdictions and are coordinated through the Convention on Biological Diversity. Concurrently, each member state is responsible for defining EBSAs in its own EEZ. However, these EBSAs exist merely as biologically determined definitions and are not subject to legislative measures. Despite this ambiguity, the Japanese government has defined three types of EBSA: the coastal area, the offshore surface area and the deep-sea floor.<sup>11</sup> Japan has announced that it will establish Marine Protected Areas (MPAs)<sup>12</sup> on the deep-sea floor EBSA near the Ogasawara Islands. However, the location and extent of these prospective MPAs have not been disclosed at the time of writing. Geoparks and Biosphere Reserves (BR) have also been established in Japan with the aim of protecting some areas of the EEZ, while the surrounding areas are targeted for resource use. Through Geoparks, such as the Oki Islands Geopark, the Japanese government aims to conserve unique geodiverse areas<sup>13</sup> (see Eder, 2008) to encourage the preservation of geological, biological and cultural resources of a territory (Brilha, 2018). Japan is currently discussing the potential to install a BR or a Geopark on the deep sea floor, which will incorporate both DSM and MPAs. However, it remains unclear as to how adjacency rights for contiguous communities will be negotiated if this is established.

Aside from the kind of 'ocean grabbing' (Barbesgaard, 2018) seen in the emergent DSM industry, other political dynamics are occurring in which the state plays a key, yet relational role. DSM is witnessing new moves firstly towards 'modes of resource and environmental certification that supersede state sovereignty' and secondly, towards 'the continuing hybridization of neoliberal modes of environmental governance' wrought by public-private partnership (Bridge, 2014: 118). Both of these moves can be seen in the context of Japan. In the first instance, Japan has been at the forefront of trying to develop new ISO standards for the exploitation and environmental management of DSM.<sup>14</sup> These proposals involve the negotiation of different political norms across several countries, notably China and the UK, and have attempted to develop standards for the quality of seawater, for the observation of deep-sea fauna, and for long-term environmental surveying practices (JAMSTEC, 2017). As of January 2020, Working Group 4 of the ISO TC8/SC13 on marine technology is developing seven standards that will contribute to Marine Environmental Impact Assessments. Japanese scientists have proposed four of these seven standards: General technical requirement on marine environment impact assessment (ISO/AWI 23730), Long-term in-situ image based surveys in deep sea environments (ISO/AWI 23731), General Protocol for Observation of meiofaunal community (ISO/AWI 23732) and On-board bioassay to monitor seawater quality using delayed fluorescence of microalga (ISO/AWI 23734). Workshops have also been held by the ISA drawing upon the

<sup>11</sup> In order to achieve Aichi Biodiversity Target 10, Japan is required to establish an MPA that is equivalent to 1.6 percent of its EEZ, in addition to the MPA that is mainly in coastal areas.

<sup>12</sup> Japan has attempted to balance conservation and resource use in its MPAs. This can be seen in the case of Shiretoko National Park, where the interaction between the terrestrial peninsular area and the surrounding marine area is recognised by the government and supports the notion of 'adjacency rights.' Fishermen have been central to the establishment of its Multi Use Integrated Marine Management Plan and their voluntary efforts to improve marine conservation contributed to Shiretoko being designated as a World Heritage Site in 2005 (Makino et al., 2009; Matsuda et al., 2018).

<sup>13</sup> Geodiversity is defined by the presence of "geological heritage types or qualitative characteristics of [a] unique geological environment" (Ruban 2017: 103).

<sup>14</sup> The ISO standard justifies that the method used is a "recognised scientific" method (Seta, 2019).



experiences of several of the countries most invested in the idea of DSM (ISA, 2019). Engagement from other states is likely to increase as more countries consider exploitation. In the second instance, and as a reminder of the public–private collaborations necessary to DSM, negotiating and understanding the imperatives of state and corporate interests will be central to the future expansion of the industry.

Geopolitical approaches to DSM enable a focus on state actors, but also challenge the notion that they are the sole unit of analysis in geopolitical thinking. Turning towards a posthuman geopolitics (Dittmer, 2014), both material forces (the things that the seabed and deep-ocean environments do) and more-than-human spiritualities will be important to the emergent politics. For the question of materiality, DSM deposits develop at vastly different rates, thus ushering-in different responses to the question of environmental impact. Similarly, defining ‘serious harm’, a key legal concept which is partly used to determine who bears responsibility for DSM’s unwanted consequences, emerges from the conjunction of legal procedures, technological approaches and geophysical realities of mineral distribution and occurrence (Levin et al., 2016). On the second question of spirituality, several instances of DSM projects colliding with the belief systems of proximate community groups have already been witnessed. Childs (2019) aforementioned research, in PNG, has demonstrated how the potential impacts of DSM upon the bodies of spirits that both move through and transcend deep-ocean space were regarded as *the* most important perceived risk (Childs, 2020b). These concerns have been central to the politico-legal challenge to the PNG state forwarded by communities. Related debates have also been seen in New Zealand where offshore mining is debated in the context of Maori cosmological understandings of space echoing similar situations that have occurred around land-based extraction (see Carreño, 2017; Theriault, 2017; Taussig, 2010). Because seafloor massive sulphide deposits are predominantly associated with the Pacific ‘ring of fire’, such political flashpoints are likely to endure in the future. The questions of belief are no less relevant for other deposit types found outside of EEZs and add complexity to the often cited ‘sovereignty game’ (Hannigan, 2016). The deep-ocean space and its spiritual inhabitants must therefore be considered in relational terms.

Finally, reflecting the ‘critical’ turn in geopolitics, the linguistic and creative representations of DSM are pivotal in shaping its politics. This approach is centred less on the political ‘facts’ of DSM (i.e. where the deposits are, who controls them, how revenues are to be distributed, and so on) and more on the language and images used to describe them (see Medby, 2020). Already we are seeing how the trope of ‘sustainability’ is used to justify the exploitation of both conventional and rare earth elements alike (for the construction of everything from wind turbines to electric car batteries). Yet this kind of language stands at odds with those critics who point to its ‘unsustainability’ (in terms of the continuing expansion of the extractive frontier). Depending on who is speaking, DSM is scripted as a ‘new solution’ or a continuing case of ‘business as usual’. In short, from this perspective the real tensions are between the ways in which DSM is represented rather than between the things that it does or does not do. Clearly, creative practice (film and fine art, for example) has as much of a role to play for articulating a lexis for DSM as does the written word (such as scientific and academic reports and journalism) (Childs, 2020b). Finding a vocabulary that speaks across the disciplines in academia would allow equal room for the broad range of worldviews pertaining to the deep-ocean, and as such, negotiating political differences across political institutions from the supra-to sub-national is vital.

## 6. Conclusion

In this paper, we have highlighted the importance of considering the social sciences in discussions on DSM and in blurring the disciplinary ‘edges’ that come to define its place within contemporary scholarship. With DSM moving towards commercial viability, critical engagement with this emerging practice must go beyond the usual treatment given to

understanding mining on the seabed, which is often centred upon questions of stakeholder perceptions and social licencing. DSM brings with it complex debates that critical social sciences are well placed to address. This paper has proposed an approach that is well-placed to navigate and better understand the political questions that emerge from mining on the seabed. By engaging with geography, law, political economy and geopolitics we have demonstrated how the social sciences are necessary to analyse not only the narratives of DSM, but also the actors involved and the consequential tensions and conflicts that arise. These perspectives also enable interrogation of claims that seabed mining offers greater ‘sustainability’ than terrestrial mining does.

Unpacking the geographies of DSM reveals its complexities and cautions against perceiving DSM as a singular phenomenon. DSM cannot be understood by attending to its physical dimensions alone, important as they are. Indeed, as this paper has demonstrated, mining the deep seabed is both underpinned by, and produces, a range of social, cultural, and political dimensions. Furthermore, individuals’ experiences and interpretations of DSM are not uniform – they are contextual and dependent upon a range of unevenly distributed social and political factors. While this paper has drawn on empirical examples from Japan (and to an extent PNG and Namibia), we caution against extrapolating these cases. DSM and its associated relations will vary, and its’ different practices and contexts must be considered in any analysis. Importantly, the geographies of DSM also highlight that the practice and its’ complexities cannot be simply located at sea. DSM, in all its manifestations, is reliant on landed, terrestrial, practices and for some communities, it transcends both land and sea to be experienced and understood at a spiritual and embodied scale.

These complex and multi-scalar questions require a more holistic approach than has been the norm thus far in research on DSM. As the second section of this paper highlighted, in order to understand the emergent politics of DSM, we must first define what the ocean space and seabed are. While geographic divisions – facilitated by lines on maps that divide spaces – are considered as the basis for the application of different legal regimes, they are not politically neutral. They create ‘edges’ that define geographical limits, shaping notions of jurisdictional authority, citizenship, and questions of ownership as they do so (Jeffrey, 2020). These geographical delineations both result from, and unevenly reproduce legal power. In considering these spaces to be not just physical but also political spaces, the complexities and implications of these socially constructed lines can be understood. This enables analysis of how notions of rights (including to extraction), authority and other inclusions and exclusions related to DSM are defined through the practice of legal reasoning.

While DSM is framed as a (more sustainable) solution to resource scarcity, these discussions must go beyond traditional economic rationale. The analysis of discourse associated with DSM practices can offer insight into the drivers behind extraction, including those that exist beyond the site of the deposit. By approaching DSM through a political economic lens, we caution that an appreciation of a given context and a recognition of potential power imbalances within it is necessary. Considering the political economy of DSM also highlights the imperative of analysing all of the stages of extraction and production involved. This includes waste which must not be overlooked: it pushes back against the idea that seabed mining is located only in the deep sea. The social sciences can also help to highlight the actors involved with DSM. While multinational corporations, the state and civil society groups are involved, it is from a combination of both human and more-than-human forces that the politics of DSM emerge. The geopolitics of DSM are produced not only by different institutions but also in accordance with how different political actors relate to each other across the socio-ecological world. In recognising this, we should also appreciate that understanding historical and geographical specificities are crucial to comprehending the contemporary political relations of mining on the seabed. This recognition is vital if colonial underpinnings of DSM and uneven power relations are to be brought to the fore. As with other forms

of extraction, the potential consequences of DSM will not be experienced homogeneously.

In the light of the tensions, contradictions, and complexities of DSM, the paper concludes by arguing that an interdisciplinary approach is vital to facilitate a deeper understanding of both the practices of DSM and their consequences. As we have demonstrated DSM must be understood as a practice with extensive social, cultural, and political relations and implications. This paper has taken a step in this direction but is limited in scope, leaving several areas in need of further research. Research must engage with the finer scalar levels of DSM. While Childs (2020b: 126) offers an example of the potential of how creative practice can 'give voice to marginalised communities', the experiences of DSM – both at a community and an, individual scale – warrant further attention. This would provide an opportunity to diversify understandings and experiences of DSM. Such an endeavour would centralise actions taken by the individuals and communities that are resisting, challenging and rewriting the socio-political relations that underpin DSM (Massaro and Williams, 2013:567).

Further engagement with feminist and decolonial approaches are necessary to unpack the intersectional power dynamics that are implicit within practices of DSM. As Hyndman (2001:219) asserts, these approaches can help to identify the 'geographically and historically contingent practices' that enable and promote DSM. While such approaches may initially appear antagonistic within natural science discourse, it is precisely this juxtaposition that makes them integral to analysing the current practices and trajectories of DSM. These approaches elucidate the diverse ways in which DSM is known, practiced, and resisted. By highlighting the power dynamics and gendered representations involved in creating, prioritising, and circulating knowledges of DSM, these approaches can help to ensure inclusion of marginalised, 'more than scientific' modes of knowledges and non-dominant narratives. Similarly, questions must be asked about the ownership of, and uneven power relations pertaining to, knowledge and data related to DSM practices and the ocean itself. This has important implications for discussions of knowledge systems in relation to DSM and to highlighting issues of vulnerability, social justice and ownership.

Finally, there is also scope, as alluded to in the paper, to broaden the methods through which scholarship engages with DSM. As Childs (2020b) has demonstrated in his research on PNG, participatory research and film have provided insights that would otherwise remain obscured. Working with artists, undertaking creative practice, or exploring the processes through which creative responses to DSM are created can reveal 'politics in action' and illustrate the often-overlooked relations between 'human and non-human' actors (Hawkins, 2011: 473, see also Hawkins et al., 2015). The diverse range of methodological practices in the social sciences offers a wealth of opportunities to engage with the new relations and political questions that are emerging from DSM.

## Declaration of competing interest

There are no competing interests to declare.

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## References

- Anderson, D., 2008. Modern Law of the Sea. Martinus Nijhoff Publishers, Leiden, pp. 301–378.
- Auty, R., 2007. Natural resources, capital accumulation and the resource curse. *Ecol. Econ.* 61 (4), 627–634.
- Balayannis, A., 2020. Toxic Sights: the Spectacle of Hazardous Waste Removal. *Environment and Planning D: Society and Space*.
- Barbesgaard, M., 2018. Blue growth: savior or ocean grabbing? *J. Peasant Stud.* 45 (1), 130–149.
- Bartel, R., Graham, N., Jackson, S., Prior, J.H., Robinson, D., Shervail, M., Williams, S., 2013. Legal geography: an Australian perspective. *Geogr. Res.* 51 (4), 339–353.
- Benda-Beckmann, F., Benda-Beckmann, K., Griffiths, A., 2009. Spatializing Law: an Anthropological Geography of Law in Society. Ashgate, Farnham and Burlington.
- Blomley, N., 1994. Law, Space, and the Geographies of Power. Guildford Press, New York.
- Bond, S., Diprose, G., Thomas, A.C., 2019. 'Contesting deep sea oil: politicisation–depoliticisation–repoliticisation'. *Environ. Planning C: Pol. Space* 37 (3), 519–538.
- Boschen, R.E., Rowden, A.A., Clark, M.R., Gardiner, J.P.A., 2013. Mining of deep-sea seafloor massive sulfides: a review of the deposits, their benthic communities, impacts from mining, regulatory frameworks and management strategies. *Ocean Coast Manag.* 84, 54–67.
- Braverman, I., Blomley, N., Delaney, D., Kedar, A. (Eds.), 2014. The Expanding Spaces of Law: A Timely Legal Geography. Stanford University Press, Stanford.
- Bridge, G., 2014. Resource geographies II: the resource-state nexus. *Prog. Hum. Geogr.* 38 (1), 118–130.
- Brilha, J., 2018. Geoheritage and geoparks. In: Reynard, E., Brilha, J. (Eds.), *Geoheritage. Assessment, Protection, and Management*. Elsevier, Amsterdam, The Netherlands, pp. 323–334.
- Bruun, J.M., 2020. Invading the whiteness: science, (sub) terrain, and US militarisation of the Greenland ice sheet. *Geopolitics* 25 (1), 167–188.
- Campling, L., Colás, A., 2018. Capitalism and the sea: sovereignty, territory and appropriation in the global ocean. *Environ. Plann. Soc. Space* 36 (4), 776–794.
- Carreño, G.S., 2017. Mining and the living materiality of mountains in Andean societies. *J. Mater. Cult.* 22 (2), 133–150.
- Carver, R., 2019. Resource sovereignty and accumulation in the blue economy: the case of seabed mining in Namibia. *J. Polit. Econ.* 26 (1), 381–402.
- Childs, J., 2020a. Extraction in four dimensions: time, space and the emerging geo (-) politics of deep-sea mining. *Geopolitics* 1–25.
- Childs, J., 2020b. Performing 'blue degrowth': critiquing seabed mining in Papua New Guinea through creative practice. *Sustain. Sci.* 15 (1), 117–129.
- Childs, J., 2019. Greening the blue? Corporate strategies for legitimising deep sea mining. *Polit. Geogr.* 74, 102060.
- Coronil, F., 1997. The Magical State: Nature, Money, and Modernity in Venezuela. University of Chicago Press, Chicago.
- Davies, T., 2019. Slow violence and toxic geographies: 'Out of sight' to whom? *Environ. Plann. C: Pol. Space*.
- Delaney, D., Blomley, N., Kedar, A., 2001. Legal Geographies Reader: Law, Power, and Space. Blackwell Publishers, Oxford.
- DeLoughrey, E., 2017. Submarine futures of the anthropocene. *Comp. Lit.* 69 (1), 32–44.
- Dittmer, J., 2014. Geopolitical assemblages and complexity. *Prog. Hum. Geogr.* 38 (3), 385–401.
- Dodds, K., 2010. Flag planting and finger pointing: the Law of the Sea, the Arctic and the political geographies of the outer continental shelf. *Polit. Geogr.* 29 (2), 63–73.
- Dowler, L., Sharp, J., 2001. A feminist geopolitics? *Space Polity* 5 (3), 165–176.
- Eder, Wolfgang., 2008. Geoparks - Promotion of Earth Sciences through Geoheritage Conservation, Education and Tourism. *J. Geol. Soc. India* 72, 149–154.
- Elden, S., 2013. The Birth of Territory. University of Chicago Press, Chicago.
- Emel, J., Huber, M., Makene, H., 2011. Extracting sovereignty: capital, territory, and gold mining in Tanzania. *Polit. Geogr.* 30 (2), 70–79.
- Esteban, M., Jamero, L., Nurse, L., Yamamoto, L., Takagi, H., Nguyen, T.D., Mikami, T., Kench, P., Onuki, M., Nellas, A., Crichton, R., Valenzuela, V.P., Chadwick, C., Avelino, J.E., Tan, N., Shibayama, T., 2018. Adaptation to sea level rise on low coral islands: lessons from recent events. *Ocean Coast Manag.* 168, 35–40.
- Filer, C., Gabriel, J., 2018. How could Nautilus Minerals get a social licence to operate the world's first deep sea mine? *Mar. Pol.* 95, 394–400.
- Foley, P., Mather, C., 2019. Ocean grabbing, territorialisation and social development. *Territ. Polit. Govern.* 7 (3), 297–315.
- Gasparatos, A., Doll, C., Esteban, M., Ahmed, A., Olang, T.A., 2016. Renewable energy and biodiversity: implications for transitioning to a green economy. *Renew. Sustain. Energy Rev.* 70, 161–184.
- Gilroy, P., 1993. The Black Atlantic: Modernity and Double Consciousness. Verso, London.
- GOJ, 1950. Mining act (act No. 289 of 1950). <http://www.cas.go.jp/jp/seisaku/hourei/data/mna.pdf>. (Accessed 14 February 2020).
- GOJ, 2011. Mining act. [http://www.japaneselawtranslation.go.jp/law/detail\\_main?id=29&vm=2&re=](http://www.japaneselawtranslation.go.jp/law/detail_main?id=29&vm=2&re=). (Accessed 14 February 2020).
- GOJ, 2018. Cross-ministerial strategic innovation Programme. <https://www.jamstec.go.jp/sip/pdf/resultList201807.pdf>. (Accessed 1 February 2020).

- GOJ, 2018. Strategic energy plan. [https://www.enecho.meti.go.jp/en/category/others/basic\\_plan/5th/pdf/strategic\\_energy\\_plan.pdf](https://www.enecho.meti.go.jp/en/category/others/basic_plan/5th/pdf/strategic_energy_plan.pdf). (Accessed 14 February 2020).
- Hannigan, J., 2016. The Geopolitics of Deep Oceans. Polity Press, Cambridge.
- Harris, L.M., 2017. Political ecologies of the state: recent interventions and questions going forward. *Polit. Geogr.* 58, 90–92.
- Hau'ofa, E., 1994. Our sea of islands. *Contemp. Pac.* 6 (1), 148–161.
- Havice, E., Zalik, A., 2019. Ocean frontiers: epistemologies, jurisdictions, commodifications. *Int. Soc. Sci. J.* 68 (229–230), 219–235.
- Havice, E., 2018. Unsettled sovereignty and the sea: mobilities and more-than territorial configurations of state power. *Ann. Assoc. Am. Geogr.* 108 (5), 1280–1297.
- Hawkins, H., 2011. Dialogues and Doings: Sketching the Relationships Between Geography and Art Geography *Compass*, 5 (7), 464–478.
- Hawkins, H., Cabeen, L., Callard, F., Castree, N., Daniels, S., DeLyser, D., et al., 2015. What might GeoHumanities do? Possibilities, practices, publics, and politics. *GeoHumanities* 1 (2), 211–232.
- Hoagland, P., Beaulieu, S., Tivey, M., Eggert, R., German, C., Glowka, L., et al., 2010. Deep-sea mining of seafloor massive sulphides. *Mar. Pol.* 34, 728–732.
- Hogg, C., 2007. Japan Uses Coral to “Grow” Islets. BBC News. Available at: <http://news.bbc.co.uk/2/hi/asia-pacific/6758271.stm>. (Accessed 29 January 2020).
- Hyndman, J., 2001. Towards a feminist geopolitics. *Canadian Geographer/Le Géographe Canadien* 45 (2), 210–222.
- International Court of Justice, 1969. North Sea continental shelf cases, judgment of 20 february 1969. Available online at: <https://www.icj-cij.org/files/case-related/52/5563.pdf>. (Accessed 12 December 2019).
- ISA, 2019. Workshop on the development of standards and guidelines for the mining code. <https://www.isa.org/jm/workshop/workshop-development-standards-and-guidelines-mining-code>. (Accessed 10 December 2019).
- Japan times, 2017. Japan successfully undertakes large-scale deep-sea mineral extraction. Available at: <https://www.japantimes.co.jp/news/2017/09/26/national/japan-successfully-undertakes-large-scale-deep-sea-mineral-extraction/#.XbF43OhKjcs>. (Accessed 9 September 2019).
- JAMSTEC, 2017. Latest progress on development of technical standards for use in marine environment impact assessment and the potential benefits for capacity building. [http://www.cosie-sip.ynu.ac.jp/wp-content/uploads/2017/07/PrepCom4side\\_event\\_170717\\_agenda.pdf](http://www.cosie-sip.ynu.ac.jp/wp-content/uploads/2017/07/PrepCom4side_event_170717_agenda.pdf). (Accessed 10 December 2019).
- Jeffrey, A., 2020. The Edge of Law: Legal Geographies of a War Crimes Court. Cambridge University Press, Cambridge.
- Kamishiro, N., Sato, T., 2009. Public acceptance of the oceanic carbon sequestration. *Mar. Pol.* 33 (3), 466–471.
- Klinger, J., 2018. Rare Earth Frontiers: from Terrestrial Subsoils to Lunar Landscapes. Cornell University Press, Ithaca, London.
- Knapp, F.L., 2016. The birth of the flexible mine: changing geographies of mining and the e-waste commodity frontier. *Environ. Plann.: Econ. Space* 48 (10), 1889–1909.
- Koschinsky, A., Heinrich, L., Boehnke, K., Cohrs, J.C., Markus, T., Shani, M., et al., 2018. Deep-sea mining: interdisciplinary research on potential environmental, legal, economic, and societal implications. *Integrated Environ. Assess. Manag.* 14 (6), 672–691.
- Le Meur, P.-Y., Arndt, N., Christmann, P., Geronimi, V., 2018. Deep-sea mining prospects in French Polynesia: governance and the politics of time. *Mar. Pol.* 95, 380–387.
- Levin, L.A., Mengerink, K., Gjerde, K.M., Rowden, A.A., Van Dover, C.L., Clark, M.R., et al., 2016. Defining “serious harm” to the marine environment in the context of deep-seabed mining. *Mar. Pol.* 74, 245–259.
- Lowe, V., 2012. Was it worth the effort? *Int. J. Mar. Coast. Law* 27, 1–7.
- Mabon, L., Kita, J., Xue, Z., 2017. Challenges for social impact assessment in coastal regions: a case study of the Tomakomai CCS Demonstration Project. *Mar. Pol.* 83.
- McLellan, B., 2015. Sustainability assessment of deep ocean resources. *Procedia Environ. Sci.* 28 (C), 502–508.
- Makino, M., Matsuda, H., Sakurai, Y., 2009. Expanding fisheries Co-management to ecosystem-based management: a case in the Shiretoko world natural heritage area, Japan. *Mar. Pol.* 33, 207–214.
- Massaro, V.A., Williams, J., 2013. Feminist geopolitics. *Geogr. Compass* 7 (8), 567–577.
- Matsuda, H., Makino, M., Vlachopoulou, E.I., 2018. Drawing plans of a house that already stands: knowledge systems of the Shiretoko region, a world heritage site of Japan. In: Sato, T., Chabey, I., Helgeson, J. (Eds.), *Transformations of Social-Ecological Systems: Studies in Co-creating Integrated Knowledge toward Sustainable Futures*. Springer, pp. 55–75.
- Medby, I.A., 2020. Political geography and language: a reappraisal for a diverse discipline. *Area* 52, 148–155.
- Moore, A., 2008. Rethinking scale as a geographical category: from analysis to practice. *Prog. Hum. Geogr.* 32 (2), 203–225.
- Moore, S.A., 2011. In: Watts, J. (Ed.), “Global Garbage: Waste, Trash Trading, and Local Garbage Politics” in *Global Political Ecology*, Richard Peet, Paul Robbins and Michael. Routledge, London.
- Motoori, R., McLellan, B.C., Tezuka, T., 2015. Economic Feasibility Impacts of Waste and Waste Water Treatment Regulations for Deep Ocean Hydrothermal Ore Mining in Japan. *International Society of Offshore and Polar Engineers*, 27 July 2015.
- Motoori, R., McLellan, B., Tezuka, T., 2018. Environmental implications of resource security strategies for critical minerals: a case study of copper in Japan. *Minerals* 8 (12).
- Murphy, M., 2017. Alterlife and decolonial chemical relations. *Cult. Anthropol.* 32 (4), 494–503.
- NOAA, 2020. The US coast pilot. Available online at: [https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp2/CPB2\\_C01\\_WEB.pdf](https://nauticalcharts.noaa.gov/publications/coast-pilot/files/cp2/CPB2_C01_WEB.pdf). (Accessed 14 April 2020).
- Nunn, N., 2018. Toxic encounters, settler logics of elimination, and the future of a continent. *Antipode* 50 (5), 1330–1348.
- Paasi, A., 2004. Place and region: looking through the prism of scale. *Prog. Hum. Geogr.* 28, 536–546.
- Peters, K., Steinberg, P., Stratford, E., 2018. Territory beyond Terra. Rowman and Littlefield, London.
- Peters, K., Steinberg, P., 2019. The ocean in excess: towards a more-than-wet ontology. *Dialogues Hum. Geogr.* 9 (3), 293–307.
- POST, 2015. Deep sea mining. POST note 508 (September), 1–2.
- Power, M., Newell, P., Baker, L., Bulkeley, H., Kirshner, J., Smith, A., 2016. The political economy of energy transitions in Mozambique and South Africa : the role of the Rising Powers. *Energy Res. Soc. Sci.* 17, 10–19.
- Pulido, L., 2000. Rethinking environmental racism: white privilege and urban development in southern California. *Ann. Assoc. Am. Geogr.* 90 (1), 12–40.
- Roche, C., Bice, S., 2013. Anticipating social and community impacts of deep sea mining. In: Baker, E., Beaudoin, Y. (Eds.), *Deep Sea Minerals and the Green Economy. Secretariat of the Pacific Community, Noumea*, pp. 59–80.
- Ruban, D., 2017. Geodiversity as a precious national resource: A note on the role of geoparks. *Resour. Pol.* 53, 103–108.
- Ruckstuhl, K., Thompson-Fawcett, M., Rae, H., 2014. Māori and mining: indigenous perspectives on reconceptualising and contextualising the social licence to operate. *Impact Assess. Proj. Apprais.* 32 (4), 304–314.
- Rozwadowski, H., 2012. Arthur C. Clarke and the limitations of the ocean as a frontier. *Environ. Hist.* 17 (3), 578–602.
- Sawada, Y., Tanaka, J., Suzuki, C., Tanase, D., Tanaka, Y., 2018. Tomakomai CCS demonstration project of Japan, CO2 injection in progress. *Energy Procedia* 154, 3–8.
- Seta, M., 2019. The contribution of the International Organization for Standardization to ocean governance. *Rev. Eur. Comp. Int. Environ. Law* 28, 304–313.
- Silver, J.J., Campbell, L.M., 2018. Conservation, development and the blue frontier: the republic of Seychelles’ debt restructuring for marine conservation and climate adaptation program. *Int. Soc. Sci. J.* 68, 241–256.
- Singh, S., Yamamoto, L., 2016. Spectre of China’s artificial islands. *Indian Defence Rev.* 30, 3.
- Squire, R., 2016. Immersive terrain: the US navy, sealab and cold war undersea geopolitics. *Area* 48 (3), 332–338.
- Taussig, M.T., 2010. *The Devil and Commodity Fetishism in South America*. University of North Carolina Press: Chapel Hill [1980].
- Theriault, N., 2017. A forest of dreams: ontological multiplicity and the fantasies of environmental government in the Philippines. *Polit. Geogr.* 58, 114–127.
- Tsing, A.L., 2003. Natural resources and capitalist frontiers. *Econ. Polit. Wkly.* 38 (48), 5100–5106.
- United Nations, 1958a. Convention on the Continental Shelf, vol. 499. United Nations Treaty Series No. 7302. Available online at: <https://treaties.un.org/doc/Publication/UNTS/Volume%20499/volume-499-I-7302-English.pdf>. (Accessed 12 December 2019).
- United Nations, 1958b. Convention on the Territorial Sea and the Contiguous Zone, vol. 516. United Nations Treaty Series No. 7477. Available online at: <https://treaties.un.org/doc/Publication/UNTS/Volume%20516/volume-516-I-7477-English.pdf>. (Accessed 12 December 2019).
- United Nations, 1982. Convention on the Law of the Sea, vol. 31363. United Nations Treaty Series Nos. 1833/1834/1835. Available online at: <https://treaties.un.org/doc/Publication/UNTS/Volume%201833/volume-1833-A-31363-English.pdf>. (Accessed 12 December 2019).
- United Nations, 1994. Agreement relating to the implementation of Part XI of the convention. Available online at: [https://www.un.org/Depts/los/convention\\_agreements/texts/unclos/closindxAgree.htm](https://www.un.org/Depts/los/convention_agreements/texts/unclos/closindxAgree.htm). (Accessed 12 December 2019).
- Van Dover, C.L., 2010. Mining seafloor massive sulphides and biodiversity: what is at risk? *ICES J. Mar. Sci.* 68, 341–348.
- Van Dover, 2011. Mining seafloor massive sulphides and biodiversity: what is at risk? *ICES J. Mar. Sci.* 341–348.
- Winder, G.M., Le Heron, R., 2017. Assembling a Blue Economy moment? Geographic engagement with globalizing biological-economic relations in multi-use marine environments. *Dialogues Hum. Geogr.* 7 (1), 3–26.
- World Trade Organisation, 2010. World Trade Report 2010, Trade in Natural Resources. WTO Publications. World Trade Organization, Switzerland.
- Xue, G., 2012. How much can a rock get? In: Norduis, M.H., et al. (Eds.), *The Law of the Sea Convention: US Accession and Globalization*. Martinus Nijhoff, The Hague, pp. 371–381.
- Yamamoto, L., Esteban, M., 2009. Vanishing island states and sovereignty. *Ocean Coastal Manag.* J. 53 (1), 1–9.
- Yamamoto, L., Esteban, M., 2014. Atoll Island States and International Law – Influence of Climate Change on Sovereignty and Human Rights. Springer, New York.
- Yoshikawa, Y., 2007. The US-Japan-China mistrust spiral and Okinotorishima. *The Asia-Pacific. J.: Japan Focus* 5 (10), 1–8. <https://apjif.org/-Yukie-YOSHIKAWA/2541/article.html>. (Accessed 29 January 2020).